



*Testing of the new integrated light rail extension, part of T-REX's mammoth scope.*

## **COLORADO** Colorado's T-Rex: Mega, Multi-modal, Design-Build

When the Colorado Department of Transportation began planning to reconstruct metropolitan Denver's I-25/I-225 Southeast Corridor and to extend the region's light rail system, traditional methods and practices presented steep challenges. Faced with a 15 to 20 year construction window – and disruption to motorists that promised to span nearly a generation – officials made the decision to put customers, quality and cost-effectiveness at the forefront. The result is the largest design-build construction contract in the United States and a project that is now sprinting into its final year on schedule thanks to decisions and practices that exemplify Highways for LIFE principles.

Denver's Transportation Expansion Project, dubbed T-REX, has a total project budget of \$1.67 billion, anchored by the \$1.2 billion design-build contract. The multi-modal project has sparked multi-faceted innovations that will replace an outdated system with modern, safe, efficient highway, bridge and commuter options.

T-REX spawned the first design-build type contract in the country that combines major highway and transit elements. The project encompasses light rail, highway, bike and pedestrian options, and is driven by collaboration among members of a unique development team consisting of the Colorado Department of Transportation (CDOT), Regional Transportation District (RTD), Federal Highway Administration (FHWA), Federal Transit Administration (FTA), and city, county and regional agencies. Southeast Corridor Constructors (SECC) is the contractor for the design-build approach, which encourages flexibility and creativity as designing and constructing occur simultaneously.

Asked for his views on the overarching T-REX challenges and innovations, project director Larry Warner of the Colorado Department of Transportation says, “T-REX’s top four defining elements are its multi-modal nature, the use of design-build, its financing, and accelerated construction.”

He continues, “These have also proven the keys to achieving our project goals of minimizing inconvenience to the public, meeting or beating the total project budget, delivering a quality project, and completing the project on schedule. We’re within budget and on target to finish the 17 miles of highways in September, 2006 and the 19 miles of light rail in December 2006.”

### **Highways and Transit for Life: Process and Partners**

T-REX is a success story showcased by the Highways for LIFE program for its application of practices that achieve safer, better highways and faster, more cost-effective delivery. The highway and light rail project affects 230,000 commuters a day and will bring relief in a heavily congested, rapidly growing business corridor in which traffic volumes rise even faster than increases in population and employment.

A key gauge of the success of the T-Rex approach is time: the original schedule for this mega-project specified fully operational status by June, 2008, but the use of design-build and value engineering allowed the contractor, SECC, to shave 22 months off the date and commit to completion by fall, 2006.

Money also features prominently in the T-Rex success story. Financing features include no new taxes, no increased taxes, and cost savings from accelerated construction. Highway elements were financed through bonding of future federal allocations, while transit elements were funded through bonding from sales tax revenues, FTA funds, and local jurisdiction matching funds.

Anchoring all of the project’s innovative solutions is teamwork. SECC leads the industry side of the T-REX team and is a joint venture of the Kiewit Construction Company and Parsons Transportation Group. Kiewit is the prime contractor and has multiple subcontractors; Parsons is the lead designer with a group of sub-consultants. Nationally recognized design and geotechnical consultants also working on the project include DMJM-HARRIS, HNTB Corporation, Turner Collie & Braden, Sverdrup Jacobs Civil, Inc., and Kleinfelder, Inc. Serving as subcontractors and suppliers are the Massachusetts Electric Company, Sturgeon Electric Company, Inc., Dynalectric Company of Colorado, and Anderson Drilling.

Many players, many solutions, one vision: to improve the region’s transportation system and add commuting options while curbing construction disruption.

### **Multi-modal Matters**

T-REX has been termed the “next generation” of transportation projects in part for its multi-modal nature. The design-build contract is split roughly

50-50 between highway and transit. The project also entails a contract for the purchase of 34 light rail vehicles and a separate light rail maintenance facility representing a \$40 million investment. The expected outcome is impressive – and complex.

**Light rail construction will:**

- Add 19 miles of double-track light rail with west side alignment along I-25 and median alignment along I-225
- Build 13 stations with 6,000 parking spaces (5 new parking structures)
- Add 34 light rail vehicles to RTD's fleet
- Result in a new maintenance facility

**Highway elements will result in:**

- Four through lanes from Logan to I-225
- Five through lanes from I-225 to C-470/E-470
- Three through lanes on I-225 to Parker Road

**T-REX will also:**

- Reconstruct eight interchanges, including I-25/I-225
- Replace bridges
- Improve drainage
- Enhance safety with acceleration/deceleration lanes
- Add shoulders
- Improve ramps

One of the ways T-REX is breaking new ground is the project's structure as a "One DOT" project in a tight corridor in which it has proven cost effective and expedient to make both road and light rail improvements at one time. "One DOT" is a U.S. Department of Transportation multi-modal management strategy that stresses collaboration between agencies to reduce duplication and save resources.

"From a construction standpoint, there have been unique challenges inherent in multi-modal work," Warner says. "For example, we've had to rebuild the highway and construct the new light rail side by side, sharing the right-of-way."

Craig Actis, the Federal Highway Administration T-REX project administrator, notes the benefits. "With the same design-builder designing and constructing both within a tight right-of-way, the team has realized more efficiencies in time, cost and reduced inconvenience to the public than if two separate endeavors were going on."

"Since we're under traffic," says Warner, "The design-build contractor has had to be especially innovative in meeting the requirement to maintain three lanes in each direction during the day. Meeting the public's needs means not shutting down the highway during the day. The SECC also performs a lot of work at night. Demolition and erection of prefabricated bridge girders, for instance, has been completed overnight, with lanes opening in time for morning rush hours."

Packaging the undertaking into a single design-build project has sparked a tighter collective focus on the customer while generating opportunities for the kind of inventive practices advocated by FHWA's Highways for LIFE.

## Design-Build a Highway for LIFE: Process and Partners

“Collaborating design and construction staff opens the door to lots of innovation,” says Warner. “We’ve had nine value engineering change proposals where innovations by the designer-builder have come into play. As cost savings emerge, CDOT/RTD and the SECC share the savings. An example was an improved, more creative design for the I-25/I-225 interchange.”

The owner agencies conducted all environmental planning and about 30 percent of the design for the civil elements (with a higher level of design for the light rail systems and stations). They provided the design-build contractor with 30 percent design reference drawings. The design-build contractor took it from there.



*Night paving proceeds along I-25, helping meet T-REX's ambitious five-year timetable.*

Using design-build, construction could begin before the final design was complete, design and construction phases were integrated for speed and economy, and inventive techniques were encouraged, creating the potential for cost-savings. Such practices exemplify the Highways for LIFE approach, setting demanding goals for quality, schedule, and budget.

The design-build concept was formalized with a CDOT/RTD partnership formed in 1999 when Tom Norton, CDOT executive director, and Cal Marsella, RTD general manager, signed an Intergovernmental Agreement to work cooperatively to finance and construct the multi-modal project and enter into a single design-build contract using Best Value rather than low bid methodology.

The partnership hinged on a single project team concept—an owner-managed process with private sector support. The unique agreement outlined the development of specifications for the project, the composition of the team to select the design-build contractor, and how the project would comply with Federal and State laws including Disadvantaged Business Enterprises.

Partnering and collaboration are pivotal in a design-build environment, where the number of issues requiring decisions and the speed of decision-making increase sharply from that of traditional design-bid-build projects. The T-REX partnering process allows members to resolve design and constructability issues before they arise in the field through a management framework served by a neutral Dispute Resolution Board. The project demonstrates the fact that cost savings from design-build contracts are often attributed to a closer working relationship between the designer and contractor, who incorporate greater efficiencies throughout the construction process.

For T-REX, such efficiencies began in the design-build selection process, which established an Upset Price in the Request for Proposals of \$1.225 billion. Selection was made on a Best Value basis involving both a technical and a price proposal. The SECC's proposal was \$1.186 billion, representing a \$39 million difference between the original estimate and the proposal.

The technical elements under consideration included:

- Ability to meet project goals;
- Team organization and experience;
- Ability to implement the project per the RFP;
- Innovative approaches to construction and handling traffic;
- Commitment to public information and stakeholder input.

With design-build, activities that would normally be done in sequence are done simultaneously where possible, significantly compressing the project schedule. While early completion prompts benefits, fast-tracking itself has the potential for reducing costs. That is where the type of careful planning and financing used in the development of T-REX make a real difference.

### **Progressive Financing**

The big question of how to pay for T-REX ultimately became an issue for public consideration and vote. The final funding approach came together in several steps. State legislative initiatives passed in 1999 allowed Colorado to use Transportation Revenue Anticipation Notes (TRANS) for budgeting purposes. TRANS let Colorado borrow against federal monies not yet granted to the state to fund transportation projects. Another bill allowed design-build/Best Value contract selection, rather than low bid. Voters approved bond initiatives for project funding and endorsed the idea of light rail through the southeast corridor. The net effect: CDOT and RTD could proceed with the project without having to divert funds earmarked for other construction activity and the project could move forward as a whole, instead of in segments.

With a single contractor group able to bid on the entire project, CDOT and RTD had the opportunity to join forces in asking for federal grants and municipal matching funds. Further enhancing the project's cost-effectiveness, innovative funding, combined with the design-build approach, allowed the SECC to reach for the project's early completion.



The light rail component of T-Rex also presented opportunities for innovation. Of the T-REX total project cost of \$1.67 billion, \$879 million is for rail, and \$795 million is for highways. Local jurisdictions contributed millions to help ensure federal financial support for the light rail construction. CDOT will partially finance the expansion through GARVEE bonds (Grant Anticipation Revenue Vehicle), a debt financing instrument that enables debt-related expenses to be paid with future Federal-aid highway apportionments, creating an immediate and reliable source of funds.

Historically, construction projects that use bonding save taxpayer dollars, and T-REX is no exception. Capital-intensive projects that combine innovative contracting with financing mechanisms capable of generating up-front capital enable construction to begin earlier than might be feasible using traditional pay-as-you-go resources. With projects in place sooner, costs are reduced by inflation savings and the public enjoys the safety, reduced congestion, and economic benefits of accelerated construction: all of which reflect principles of the Highways for LIFE program.

### **T-REX Construction Snapshots**

A single design-build contract and innovative financing opened the door to the “tried and true” as well as the new in terms of T-REX project practices.


In the tried and true category were prefabrication and preassembly. “Concrete girders and bridges have been cast offsite,” Warner says, “and so have the sound wall panels and fascia panels that covered the drilled shaft caisson walls, tie-back and soil-nail walls.”

As to the new – new to CDOT, Warner notes – a fresh approach was taken in regard to retaining wall construction at the right-of-way. “The drilled shaft caisson technology under the ground worked so well that we expect to use it more in the future. The drilling and placement of caissons allows the construction of a wall before excavation is complete and permits a smaller wall construction area.”

Actis adds, “With design-build, you don’t tell the contractor ‘how,’ but rather use performance specifications to the greatest extent possible. SECC designed and constructed many different wall types on the project within a very constrained right-of-way. One of the benefits of design-build is that the contractor is usually in the best position to determine the wall type that is most economical for each situation.”

One cost-efficient solution devised by the contractor reduces construction noise to adjoining neighborhoods through the use of portable, mobile sound walls – actually semi-trailers that are simply lined up alongside the highway – a reminder that innovation often includes novel uses for common resources.

Traffic management provides another snapshot of challenges addressed by the T-REX team. To meet the traveling public’s expectations for timely,

A faint, grayscale background image of a construction crane, likely a tower crane, is visible behind the text. The crane's lattice structure and jib are prominent, extending diagonally across the page.

accurate information, managers and engineers place a premium on traffic management systems and sensors to keep people informed of progress, including real-time project information and a comprehensive web site: [www.trexproject.com](http://www.trexproject.com).

Contractor, SECC, prepared a detailed, multi-phased traffic plan, designed to keep traffic flowing on the busy highways throughout the construction period. The project also incorporates state-of-the-art traffic monitoring, control, and information systems that will serve both the construction phase and the completed facilities.

An early goal was to establish a traffic management center with ITS technologies – like the Autoscope wide area vehicle detection system – deployed in the field to support a creative public information plan that helps motorists select the best routes, curbs congestion, boosts safety, and speeds coordinated response to incidents.

Live traffic monitoring information is transferred to a web portal accessed via the T-REX web site and is available 24/7 to news organizations and the traveling public, augmenting a regular “T-REX Weekly Construction Report,” a 24-hour project information line (303-786-T-REX), the CDOT highway advisory radio station, and resources of the City and County of Denver.

Many other customer-centered initiatives reside at the heart of T-REX construction, and lighting is a final example. Using criteria recently established by other cutting edge projects around the country, the team developed limits for the amount of light reaching buildings outside the highway right-of-way. They considered the fact that shields might even be placed directly on lamps to ensure that light pollution requirements were met.

Those requirements, enacted by the Colorado Legislature in 2001, were strict, mandating the use of lamps that reduce the light that directly affects surrounding properties while more than adequately providing for driver safety.

The original highway lighting design for T-REX required 40-foot light poles with 400-watt lamps planted every 180 feet along both sides of both Interstates, I-25 and I-225 – or more than 1,500 light poles for the 17-mile project. To the T-REX team, that represented excessive lighting, so they resolved to come up with something better.

Using the Value Engineering process, the team did just that. The new design, phased in over the course of the project, uses 1,000-watt lamps mounted on 65-foot poles placed about every 370 feet in the highway median – reducing the number of required light poles from 1500 to about 250. Despite the higher wattage and higher poles, placement in the highway median positioned lights 68 to 80 feet farther away from properties closest to the highways.

## Lessons Learned

CDOT's Larry Warner reflects that replacing an outdated, aging, problem-plagued highway system with one that increases mobility and improves safety, while meeting demanding goals for quality, schedule and budget, has provided valuable lessons in terms of project management.

The T-REX team keeps scrupulous records of lessons learned, having completed two formal reports to date, with a final report due in 2006. The lessons include:

- Ironing out the details of risk assessment or assignment of risk with the design-build contractor early in the process to determine which risks are best carried by the owner and which should be borne by the design-build contractor. Proper allocation of risk will result in lower overall risk for the project.
- Cost-validation of early estimates to guarantee realistic cost estimating going into the process.
- Development of realistic project goals.
- Co-location of staff: for T-REX, the owner team shares office space with the design-build contractor team. The mingling of owner and contractor resources ensures the right skills mix and facilitates communications and partnering.
- Partnering that can produce faster, more cost effective methods of designing and building projects and provides support for innovations and higher quality.
- An effective public information program.

Additional advice for mega-project officials:

- third party issues should be tied down in terms of financial understandings;
- the level of participation in the final design review process should be defined very clearly; and
- it is essential to specify how contractors will get permits, how agency coordination will be handled, and the level of participation from the community and neighborhoods.

Returning to the primary goal of T-REX, Warner reiterates that the public's convenience has to remain on the front burner from day one. If stakeholders in the local community recognize how the project will improve the quality of their lives, and remain fully informed, they will feel and respond as part of the team.

He concludes, "I think the public understands that we've been open and honest in what they could expect, and that avoiding gridlock and traffic jams has been part of the plan all along. Overall, traffic has flowed through the corridor pretty well, and much-enhanced mobility for the region is on the horizon as T-REX enters its final year."